WHAT IS CLAIMED IS:

1. In a system for locating an in-ground cable in a region using a cable locating signal which is transmitted from the length of the cable, a method comprising the steps of:

using a locator, sensing a first locating signal strength at a first operator determined distance generally in vertical alignment with an overhead surface position which is generally overhead of the cable;

measuring the first operator determined distance from the overhead surface position;

moving the locator to a second operator determined distance from the overhead surface position generally in vertical alignment with the overhead surface position;

sensing a second locating signal strength at the second operator determined distance;

measuring the second operator determined distance from the overhead surface position; and

determining the depth of the cable using the first and second signal strengths and the first and second distances.

2. The method of claim 1 wherein the steps of measuring the first and second operator determined distances each include the step of ultrasonically detecting distance to the surface of the ground using said locator.

3. The method of claim 1 wherein the depth of the cable is determined using the expression

$$D_c = \frac{h_2 b_2 - h_1 b_1}{b_1 - b_2}$$

where D_c is the depth of the cable, b_1 and b_2 are the first and second locating signal strengths of the locating field, respectively, at the first and second operator determined distances given as h_1 and h_2.

4. In a system for locating an in-ground cable in a region using a locating signal which is transmitted from the length of the cable, a locator comprising:

a first arrangement for sensing a signal strength of the locating signal at an operator determined distance from a surface position on the ground;

a second arrangement for measuring the operator determined distance from the surface position;

a processing arrangement cooperating with the first and second arrangements and configured for accepting a first signal strength measured at a first operator determined distance generally vertically above a particular surface position on the ground which is itself generally vertically above the cable and a second signal strength measured at a second operator determined distance generally vertically above said particular surface position and configured for determining a depth of the cable using the first and second signal strength measurements and the first and second operator determined distances.

5. The locator of claim 4 wherein the second arrangement is configured for ultrasonically detecting the first and second operator determined distances to the surface of the ground.

6. The locator of claim 4 wherein the processing arrangement is configured for determining the depth of the cable using the expression

$$D_c = \frac{h_2 b_2 - h_1 b_1}{b_1 - b_2}$$

where D_c is the depth of the cable, b_1 and b_2 are the first and second locating signal strengths of the locating field at the first and second operator controlled distances given as h_1 and h_2, respectively.

7. In a system for locating an in-ground cable in a region using a locating signal which is transmitted from the length of the cable, a method for determining the depth of the cable using a locator, said method comprising the steps of:

at a first point with reference to the surface of the ground, defining a generally horizontal locating direction toward a second point;

measuring a first intensity of the cable locating signal at the first point with the locator oriented toward the second point along said locating direction;

moving the locator to the second point;

measuring a second intensity of the cable locating signal at the second point;

determining a distance between the first and second points along said locating direction; and

using the measured first and second intensities and the determined distance between the first and second points, determining the depth of the cable.

8. The method of claim 7 wherein said first and second points are on one side of the cable in a plan view.

9. The method of claim 7 wherein said first and second points are on opposite sides of said cable in a plan view.

10. The method of claim 7 wherein the first and second intensities are measured along a set of three orthogonally opposed axes using said locator.

11. The method of claim 7 wherein the step of determining the depth of the cable includes the step of determining an angle γ between a direction that is normal to the cable and the locating direction in a plan view.

12. The method of claim 11 wherein the step of determining the angle γ includes the steps of using the first intensity of the cable locating signal to provide a horizontal flux intensity made up of a first flux component b_{u_1} that is parallel to the locating direction and a second flux component b_{v_1} that is normal to the locating direction and determining γ using the expression:

$$\tan\gamma = \frac{b_{v_1}}{b_{u_1}}.$$

13. The method of claim 7 wherein the step of determining the depth of the cable includes the step of determining a total horizontal flux intensity, b_{h_1}, at the first point using the expression:

$$b_{h_1} = \sqrt{b_{u_1}^2 + b_{v_1}^2}$$

where b_{u_1} is a horizontal flux intensity component at the first point that is parallel to the locating direction and b_{v_1} is a horizontal flux intensity component at the first point that is normal to the locating direction.

14. The method of claim 7 wherein the step of determining the depth of the cable includes the step of determining a total horizontal flux intensity, b_{h_2}, at the second point using the expression:

$$b_{h_2} = \sqrt{b_{u_2}^2 + b_{v_2}^2}$$

where b_{u_2} is a horizontal flux intensity component at the first point that is parallel to the locating direction and b_{v_2} is a horizontal flux intensity component at the first point that is normal to the locating direction.

15. The method of claim 7 wherein the step of determining the depth of the cable uses the expression:

$$D_c = \frac{(\Delta s)\cos\gamma}{\dfrac{b_{w_1}}{b_{h_1}} - \dfrac{b_{w_2}}{b_{h_2}}}$$

where γ is an angle between a direction that is normal to the cable and the locating direction, b_{h_1} is a first total horizontal flux intensity at the first point, b_{h_2} is a second total horizontal flux intensity at the second point, Δs is the distance between the first and second points, b_{w_1} is a vertical flux intensity component at the first point, b_{w_2} is a vertical flux intensity component at the second point and D_c is the depth of the cable.

16. The method of claim 7 wherein the step of determining the depth of the cable uses the expressions:

$$\tan\gamma = \frac{b_{v_1}}{b_{u_1}}$$

$$b_{h_1} = \sqrt{b_{u_1}^2 + b_{v_1}^2}$$

$$b_{h_2} = \sqrt{b_{u_2}^2 + b_{v_2}^2}\ , \ and$$

$$D_c = \frac{(\Delta s)\cos\gamma}{\dfrac{b_{w_1}}{b_{h_1}} - \dfrac{b_{w_2}}{b_{h_2}}}$$

where γ is an angle between a direction that is normal to the cable and the locating direction, b_{u_1} is a horizontal flux intensity component at the first point that is parallel to the locating direction, b_{v_1} is a horizontal flux

intensity component at the first point that is normal to the locating direction, b_{u_2} is a horizontal flux intensity component at the second point, b_{v_2} is a horizontal flux intensity component at the second point that is normal to b_{u_2}, b_{h_1} is a first total horizontal flux intensity at the first point, b_{h_2} is a second total horizontal flux intensity at the second point, Δs is the distance between the first and second points, b_{w_1} is a vertical flux intensity component at the first point, b_{w_2} is a vertical flux intensity component at the second point and D_c is the depth of the cable.

17. In a system for locating an in-ground cable in a region using a locating signal which is transmitted from the length of the cable, a locator comprising:

a first arrangement for sensing a signal strength of the locating signal; and

a processing arrangement cooperating with the first arrangement and configured for using (i) a first signal strength measured at a first point with reference to the surface of the ground with the locator oriented in a generally horizontal locating direction toward a second point, (ii) a second signal strength measured at the second point and (iii) a distance determined between the first and second points to determine the depth of said cable.

18. The locator of claim 17 wherein the processing arrangement is configured for using the first and second signal strengths as measured to one side of the cable in a plan view.

19. The locator of claim 17 wherein the processing arrangement is configured for using the first and second signal strengths as measured on opposite sides of said cable in a plan view.

20. The locator of claim 17 wherein the first arrangement is configured for measuring each of the first and second intensities along a set of three orthogonally opposed axes using said locator.

21. The locator of claim 17 wherein the processing arrangement is configured for determining an angle γ between a direction that is normal to the cable and the locating direction.

22. The locator of claim 21 wherein the processing arrangement is configured for determining the angle γ using the first intensity of the cable locating signal to provide a horizontal flux intensity made up of a first flux component b_{u_1} that is parallel to the locating direction and a second flux component b_{v_1} that is normal to the locating direction and determining γ using the expression

$$\tan\gamma = \frac{b_{v_1}}{b_{u_1}}.$$

23. The locator of claim 17 wherein the processing arrangement is configured for determining the depth of the cable based, at least in part, on a total horizontal flux intensity, b_{h_1}, at the first point using the expression:

$$b_{h_1} = \sqrt{b_{u_1}^2 + b_{v_1}^2}$$

where b_{u_1} is a horizontal flux intensity component at the first point that is parallel to the locating direction and b_{v_1} is a horizontal flux intensity component at the first point that is normal to the locating direction.

24. The locator of claim 17 wherein the processing arrangement is configured for determining the depth of the cable based, at least in part, on a total horizontal flux intensity, b_{h_2}, at the second point using the expression:

$$b_{h_2} = \sqrt{b_{u_2}^2 + b_{v_2}^2}$$

where b_{u_2} is a horizontal flux intensity component at the first point that is parallel to the locating direction and b_{v_2} is a horizontal flux intensity component at the first point that is normal to the locating direction.

25. The locator of claim 17 wherein the processing arrangement is configured for determining the depth of the cable based, at least in part, on the expression:

$$D_c = \frac{(\Delta s)\cos\gamma}{\dfrac{b_{w_1}}{b_{h_1}} - \dfrac{b_{w_2}}{b_{h_2}}}$$

where γ is an angle between a direction that is normal to the cable and the locating direction, b_{h_1} is a first total horizontal flux intensity at the first point, b_{h_2} is a second total horizontal flux intensity at the second point, Δs is the distance between the first and second points, b_{w_1} is a vertical flux intensity component at the first point, b_{w_2} is a vertical flux intensity component at the second point and D_c is the depth of the cable.

26. The locator of claim 17 wherein the processing arrangement is configured for determining the depth of the cable using the expressions:

$$\tan\gamma = \frac{b_{v_1}}{b_{u_1}}$$

$$b_{h_1} = \sqrt{b_{u_1}^2 + b_{v_1}^2}$$

$$b_{h_2} = \sqrt{b_{u_2}^2 + b_{v_2}^2}\text{, } and$$

$$D_c = \frac{(\Delta s)\cos\gamma}{\dfrac{b_{w_1}}{b_{h_1}} - \dfrac{b_{w_2}}{b_{h_2}}}$$

where γ is an angle between a direction that is normal to the cable and the locating direction, b_{u_1} is a horizontal flux intensity component at the first point that is parallel to the locating direction, b_{v_1} is a horizontal flux intensity component at the first point that is normal to the locating direction, b_{u_2} is a horizontal flux intensity component at the second point, b_{v_2} is a horizontal flux intensity component at the second point that is normal to b_{u_2}, b_{h_1} is a first total horizontal flux intensity at the first point, b_{h_2} is a second total horizontal flux intensity at the second point, Δs is the distance between the first and second points, b_{w_1} is a vertical flux intensity component at the first point, b_{w_2} is a vertical flux intensity component at the second point and D_c is the depth of the cable.

27. In a region which includes at least one generally straight cable in the ground and extending across said region, from which cable a locating signal is transmitted, a method comprising the steps of:

measuring a local flux intensity, including three orthogonally opposed values, of the locating signal at an above ground point within said region using a portable locator; and

using the local flux intensity to establish an approximate horizontal distance to the cable based on a vertically oriented component of the locating signal at the above ground point determined from the local flux intensity and a horizontally oriented component of the locating signal at the above ground point determined from the local flux intensity, which horizontally oriented component is generally normal to the cable in a plan view and represents a total flux intensity in a horizontal plane.

28. The method of claim 27 wherein the vertically oriented component of the locating signal is denoted as b_w and the horizontally oriented component of the locating signal is denoted as b_h and wherein the approximate horizontal distance is estimated based on an angle α determined by the expression:

$$\tan\alpha = \frac{b_w}{b_h} \ .$$

29. The method of claim 28 wherein the locator includes an axis of symmetry and wherein b_h is given by

$$b_h = b_u\sqrt{1+\left(\frac{b_v}{b_u}\right)^2}$$

where b_u is measured along the axis of symmetry of the locator with the axis of symmetry horizontally oriented and b_v is measured horizontally normal thereto.

30. The method of claim 28 wherein tan α includes a sign and said method includes the step of using the sign of α to establish whether the cable is ahead of or behind the locator.

31. The method of claim 28 further comprising the step of determining an angle γ between a direction that is normal to the cable in a plan view and the locating direction given by the expression

$$\tan\gamma = \frac{b_v}{b_u}$$

such that γ establishes a relative direction of the cable from the locator at the above ground point with the locator oriented in the locating direction.

32. The method of claim 31 wherein said locator includes a display and wherein said method further comprises the step of displaying a positional relationship between the locator, oriented along said locating direction at the above ground point, and the cable based on γ and α.

33. In a system for use in a region which includes at least one generally straight cable in the ground and extending across said region, from which cable a locating signal is transmitted, a locator comprising:

a first arrangement for measuring a local flux intensity, including three orthogonally opposed values, of the locating signal at an above ground point;

a processing arrangement for using the local flux intensity to establish an approximate horizontal distance to the cable in a plan view based on a vertically oriented component of the locating signal at the above ground point determined from the local flux intensity and a horizontally oriented component of the locating signal at the above ground point determined from the local flux intensity, which horizontally oriented component is generally normal to the cable in a plan view and represents a total flux intensity in a horizontal plane.

34. The locator of claim 33 wherein the vertically oriented component of the locating signal is denoted as b_w and the horizontally oriented component of the locating signal is denoted as b_h and wherein the processing arrangement is configured for estimating the approximate horizontal distance based on an angle α determined by the expression:

$$\tan\alpha = \frac{b_w}{b_h}\ .$$

35. The locator of claim 34 including an axis of symmetry and wherein the processing arrangement is configured for determining b_h using the expression

$$b_h = b_u\sqrt{1+\left(\frac{b_v}{b_u}\right)^2}$$

where b_u is measured along the axis of symmetry of the locator with the axis of symmetry horizontally oriented and b_v is measured horizontally normal thereto.

36. The locator of claim 34 wherein the processing arrangement is configured for determining a sign of tan α and for using the sign of α to establish whether the cable is ahead of or behind the locator.

37. The locator of claim 34 wherein the processing arrangement is configured for determining an angle γ between a direction that is normal to the cable in a plan view and the locating direction given by the expression

$$\tan\gamma = \frac{b_v}{b_u}$$

such that γ establishes a relative direction of the cable from the locator at the above ground point with the locator oriented in the locating direction.

38. The locator of claim 37 including a display and wherein said processing arrangement is configured for determining a positional relationship based on γ and α for presentation on said display, said positional relationship including the locator oriented along said locating direction at the above ground point and the cable in a plan view.

39. In a system for locating an in-ground cable in a region using a cable locating signal which is transmitted from the length of the cable, a method comprising the steps of:

using a locator, sensing a first locating signal strength at a first operator determined distance generally in vertical alignment with a surface position which is horizontally displaced with respect to any position directly overhead of the cable;

measuring the first operator determined distance from the surface position;

moving the locator to a second operator determined distance from the surface position generally in vertical alignment with the surface position;

sensing a second locating signal strength at the second operator determined distance;

measuring the second operator determined distance from the surface position;

measuring a horizontal distance from the surface position to a point directly overhead of the cable in a direction that is normal to a surface projection of the cable; and

determining the depth of the cable using the first and second locating signal strengths, the first and second distances and the measured horizontal distance.

40. The method of claim 39 wherein the step of determining the depth of the cable uses the expression:

$$\left(\frac{b_1}{b_2}\right)^2 = \frac{s^2 + (D_c + h_2)^2}{s^2 + (D_c + h_1)^2}$$

where b_1 is the first locating signal strength, b_2 is the second locating signal strength h_1 is the first operator determined distance, h_2 is the second operator determined distance, s is the measured horizontal distance, and D_c is the cable depth.

41. The method of claim 39 wherein the first and second signal strengths are each measured along a set of three horizontally disposed axes.

42. In a system for locating an in-ground cable in a region using a cable locating signal which is transmitted from the length of the cable, a locating arrangement comprising:

a first arrangement for sensing a signal strength of the locating signal at an operator determined distance from a surface position on the ground;

a second arrangement for measuring the operator determined distance from the surface position;

a processing arrangement cooperating with the first and second arrangements and configured for accepting a first signal strength measured at a first operator determined distance generally vertically above a particular surface position on the ground which is horizontally displaced with respect to any position directly overhead of the cable and a second signal strength measured at a second operator determined distance generally vertically above said particular surface position and configured for determining a depth of the cable using the first and second signal strength measurements and the first and second operator determined distances.

43. The locating arrangement of claim 42 wherein the processing arrangement is configured for determining the depth of the cable using the expression:

$$\left(\frac{b_1}{b_2}\right)^2 = \frac{s^2+(D_c+h_2)^2}{s^2+(D_c+h_1)^2}$$

where b_1 is the first locating signal strength, b_2 is the second locating signal strength h_1 is the first operator determined distance, h_2 is the second operator determined distance, s is the measured horizontal distance, and D_c is the cable depth.

44. The locating arrangement of claim 42 wherein the first and second signal strengths are each measured along a set of three horizontally disposed axes.